OBSERVATIONS ON THE YOUNG OF RANATRA QUADRIDENTATA STAL.

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In two previously published papers [1] I have described certain features of the behavior of the water scorpion, *Ranatra*, and as opportunity presented itself this last spring of obtaining young *Ranatras* in abundance attention was devoted to a comparison of the behavior of the young and the mature forms. The various stages in the metamorphosis of the nymph were followed, but as these have recently been described by Torre-Bueno [2] the observations made on this subject are omitted.

Ranatra lays its eggs in the spring commonly in the stems of aquatic plants or floating pieces of wood. The eggs are inserted in the material containing them so that they are nearly buried. They are of cylindrical form, rounded at either end, and provided at the outer end with a pair of slender filaments of uncertain function. When one sees a *Ranatra* which has recently emerged from the egg he cannot but be surprised that the young insect should have been enclosed in so small a receptacle. The body of the young *Ranatra* is as broad as the egg and over twice as long. The length of the young, measured from the end of the proboscis to the tip of the breathing tube is frequently 8 mm., while the egg itself is only about 3 mm.

The young in general appearance closely resemble the adult form. The prothorax, however, is relatively shorter, the wings are entirely absent, and the breathing tube, or what functions as such,[3] is relatively short, being about one fourth of the length of the body, while in the adult it is about four fifths the length of the body. At first the young are very soft. The slender legs bend with the greatest ease, and if the insect is taken out of the

[1] Holmes, "The Reactions of Ranatra to Light," *Jour. Comparative Neurology and Psychology*, Vol. 15, p. 305. "Death Feigning in Ranatra," *l. c.*, Vol. 16, p. 200.

[2] Torre-Bueno, *Canadian Entomologist*, Vol. 38, p. 242, 1906.

[3] Torre-Bueno, *l. c.*, has shown that the so-called breathing tube of the young nymph differs essentially in structure from that of the adult insect.

water it is unable to support itself and wriggles about helplessly. Its integument rapidly hardens, however, and in the course of a few hours it is able to move around out of water as well as an older individual.

When first hatched the young are pale in color, but they soon become much darker, many specimens becoming quite dark in less than a day.

The manner of walking, swimming, turning over when placed on the back, and the attitudes assumed when resting at the surface of the water, or in contact with objects below the surface, are very nearly the same as in the mature insect. Soon after hatching the young *Ranatras* take up a position at the surface of the water with the tip of the breathing tube just projecting through the surface film and the body inclined obliquely downward. The second and third pairs of legs are held in a sprawled out position, while the first pair is held in front, and bent upward at the middle, with the claw held open. The position is one of readiness for quickly seizing any small object that passes within reach. Young *Ranatras* are remarkably active in the capture of prey. Any small object that strikes the outstretched arms is grabbed at with surprising quickness. If a small insect or crustacean is seized, it is drawn towards the mouth, usually with the assistance of the other arm, and the proboscis is moved about over it in the endeavor to find a soft spot through which it can penetrate. When this is found the juices of the body are gradually sucked out and the rest of the prey rejected. Young *Ranatras* will seize and suck out almost any animal not of too large size. I observed one not a day old deftly catch a small ostracod that happened to swim against one of its outstretched arms. The ostracod tightly closed the valves of its shell, but the *Ranatra* turned it over and over, exploring all sides of it with the tip of its proboscis and endeavoring in vain to force an entrance between the valves. After the round smooth ostracod was rolled about for several minutes it slipped from the grasp of its captor and swam away.

Ranatras may readily be fed by seizing a small organism in a pair of pincers and carefully bringing it up to them. Animals as large as themselves are successfully coped with. Large *Hyalel-*

las are seized and sucked out without much difficulty. While mature *Ranatras* will live together peaceably for a long time the young readily attack and devour one another. If several young are kept in the same dish it will be found that, in the course of a few days, a majority of them will have fallen victims to a few successful combatants. If a young *Ranatra* seizes another near the middle of the body it is usually able to bring its victim up to its proboscis, the tip of which is moved about in search of a soft spot in the armor of the unfortunate individual, whose blood is then deliberately sucked out notwithstanding the creature's struggles. Often a *Ranatra* is seized by one of its legs. This is usually not resented until its captor, after pushing the tip of its proboscis along the leg until it finds one of the joints, begins to insert its piercing stylets through the soft integument, when a vigorous struggle ensues.

Young *Ranatras* are exceedingly voracious creatures, as they will kill and suck out several insects as large as themselves in the course of a day. Their food consists mainly of small swimming forms, chiefly small crustaceans and insects, which come near the surface of the water. Like the adults, they are very efficient enemies of the larvæ of mosquitoes. They do not pursue their prey, and they seldom catch forms that keep in close contact with solid objects. They are like so many traps set ready to seize anything that comes in contact with them. Often, however, an object is grabbed at if it passes near a *Ranatra* without coming into actual contact with it. This action is probably a response to the impact of the water. If a *Ranatra* is hungry, touching the surface film with a needle near the insect will often cause it to grab about wildly in the effort to seize whatever may have caused the disturbance. An object of too large or threatening appearance causes the young *Ranatra* to jerk back its first pair of legs, but there are no efforts to swim away from danger. When this reaction occurs the insect cannot be induced to take food for some time.

The reactions of young *Ranatras* to light are not nearly so vigorous and decided as those of the adult. A feeble positive phototaxis is manifested the first day after hatching and increases gradually as the insect grows older. Individuals a week old are

very often found swimming on the side of the dish towards the light; if the dish is turned about they quickly swim back again to the light side. When out of water they are comparatively irresponsive to light — a fact in marked contrast to the behavior of the mature insects. Movements of the head in response to changes in the position of the light, which are so pronounced in the adults are manifested in the young of a week old or even less, but they are not very pronounced. When out of water the young could not be induced to walk toward the light or respond to it in any other way than by making rather feeble movements of the head. While contact stimuli applied to the mature insects when in the water cause a negative phototaxis, they failed in the forms experimented with to produce this effect in the young.

The death feigning of young *Ranatras* is not so decided or prolonged as in older specimens, and it also differs in certain other particulars. Young *Ranatras* when taken out of the water and laid on a table frequently become immobile in whatever position they may happen to lie. Neither in the young nor the mature form do the appendages assume any definite position such as they do in the death feint of many other insects. The feint is shown during the first day of free life. The muscular system gives evidence of a certain degree of rigidity, but owing to the flexibility of the appendages this is not so clearly manifested as in somewhat older individuals.

In specimens five days old the death feint is more decided. Several specimens of this age were taken out of a dish and laid on a table. Immediately they all became immobile. They could be picked up by one of the slender legs and held out without causing a bend in any of the joints, thus showing that the muscles were in a state of extreme contraction. Many specimens would endure considerable handling and poking about without making any response. In some cases such treatment would bring them quickly out of the feint, and all the forms experimented with were brought out of it by more prolonged stimulation. In this respect the young differ from the mature insects which will endure a great deal of maltreatment without making any response.

In specimens coming out of the death feint handling or rubbing them with a dry camel's hair brush produced in some cases a

resumption of the feint; in others it had no effect. This, too, is different from the characteristic reaction of the adults which, when they awaken from the feint, can readily be caused to resume feigning many times in succession by handling or gently stroking them. And if an adult is picked up while feigning it is rarely brought out of its feint by this means.

It is a curious fact that while the mature *Ranatra* will endure all sorts of maltreatment during the death feint, even suffering its legs to be cut off one by one or its body cut in two without the least response, the moment the insect is placed in the water the death feint entirely disappears. There is no way in which the feint can be terminated so quickly and completely as by this means. Nor is it possible by any sort of manipulation to cause the insect to feign death so long as it is in the water. It is certainly remarkable that an insect that will feign, it may be for hours, with its muscular system tense so that all its appendages are perfectly stiff should so completely and suddenly change its behavior when it is placed in another medium.

In *Ranatras* of five days old or less the death feint often persists for a time after they are placed in water. They do not, as a rule, swim directly away, as the adults do, but frequently remain motionless and apparently still for several seconds, or in some cases for over a minute. When in the air the duration of the death feint of the young is increased if they are kept wet. Specimens that refuse to feign when rubbed with a dry camel's hair brush can commonly be made to do so by rubbing them with a brush dipped in water. And when specimens cannot be induced to feign by this means they can generally be thrown into a feint by dipping them into water and then leaving them on the table. Dryness produces in the young a restlessness that is not shown by the adult, — a result not improbably due to their less ability to withstand lack of water.

The young, like the mature forms, can be cut in two while in the death feint without causing any response. A specimen which was cut across near the middle of the body showed no movement in either piece; the legs were rigid, but after being poked about for some time they began to move. Handling the anterior piece failed to cause it to feign again, but when it was dipped into the

water and placed back on the table it feigned for several minutes, the legs giving the same signs of muscular rigidity as before. Several times it came out of its feint and as many times it was caused to resume feigning by dipping it into water and placing it on the table. Contact with a wet camel's hair brush would readily cause it to feign, but a dry brush would produce no feint, or but a very short one. Other experiments gave very similar results.

It is difficult to understand how the death feint in *Ranatra* can be of much value to it. While the European *Ranatra linearis* has been known to fly to lights at night (a rare occurrence apparently) I have been unable to obtain any evidence of such a habit in any of our American species. In fact *Ranatra* very seldom leaves the water of its own accord on account of any sort of inducement, and one is therefore strongly inclined to believe that the death feint which is manifested only when the insect is in the air is rather an incidental result of certain physiological peculiarities of the organism than an instinct which has been built up by natural selection for the benefit of the species. We must adopt such a view, I think, regarding hypnotism in the higher animals and in man; for what selective value can it be to a species, such as our own for instance, to possess the capacity of being thrown into the hypnotic state? The instinct of feigning death is of unquestionable service to many forms, and it is possible that in rare instances it may have proven of selective value to *Ranatra*, but it is open to serious question if the instinct in this form has been evolved because of its importance as a means of protection.

The strong and at times almost violent positive phototaxis which *Ranatra* exhibits presents another problem of the same kind. Certain of the most striking features of this reaction are manifested only when the insect is out of water. As a rule *Ranatra* inhabits more or less shaded retreats among submerged grass or weeds near the water's edge. It is kept in such situations, partly through the direct effect of its positive thigmotaxis, and partly because contact stimuli (as shown in a previous paper) cause it to become negatively phototactic. The positive phototaxis which appears when the insect is swimming freely in the

water is certainly of no service to it in leading it into its accustomed habitat if it should, for any reason, become removed from it. In the air and near a bright light *Ranatra* becomes, sooner or later, strongly positive, often being wrought up to the highest pitch of excitement in its efforts to reach the light. Of the utility of such curious behavior it is indeed difficult to conceive a reasonable explanation.

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